REMARKS

Status Of Application

Claims 1-3, 5-8, 10-12, 14-17 and 19 are pending in the application; the status of the claims is as follows:

Claim 1, 2, 5-7, 10, 11, 14-16, and 19 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Ouellet, U.S. Patent No. 6,602,791, in view of Zanzucchi, U.S. Patent No. 5,846,396 and Dunbrow, U.S. Patent No. 6,251,343 B1, and

Claims 3, 8, 12, and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Ouellet in view of Zanzucchi and Dubrow further in view of Wikipedia.

35 U.S.C. § 103(a) Rejections

The rejection of claims 1, 2, 5-7, 10, 11, 14-16, and 19 under 35 U.S.C. § 103(a), as being unpatentable over Ouellet in view of Zanzucchi and Dubrow, is respectfully traversed based on the following.

The present application discloses various embodiments of a microfluidic invention which provides a simplified structure and certain advantages in configuration and use. Certain advantages are obtained by the specific configuration and placement of the pump unit relative to the channel unit. Specifically, the pumping mechanism is not provided on the side of the system that houses the fluid reservoir, but, instead, is located on the side with the pump unit. In this way, the driving portion of the mechanism is an independent element which can be detached from the channel unit. As described in the present specification, being able to detach the channel unit allows for easy cleaning or replacement, and allows the pumping unit to be reused.

This configuration also addresses other problems faced in other art and lessens the amount of dead volume between the pump and the channel unit thereby enhancing response and precise control of the liquids being transported.

Another aspect is the inclusion in the microfluidic device of a compact pump having a configuration that can be easily used with the device.

These features can be seen in claim 1 which, as amended herein, recites:

A microfluidic device comprising:
a pump unit including:
a first joint surface;
a pumping mechanism including:
a pumping chamber having a diaphragm to which a piezoelectric element is attached,
a first throttle channel connected to one side of the pumping chamber, and
a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element; and
a channel that forms a flow path through which a fluid flows, opposing ends of said channel each opening to the first joint surface, said pumping mechanism being disposed adjacent to said channel and being configured to control a flow of fluid through said channel;
a channel unit including a second joint surface for being detachably joined to the first joint surface and a channel that opens to the second joint surface and is connectable to one end of the channel of the pump unit, and
a member for positioning the pump unit and the channel unit with respect to each other,
wherein at least one of a material constituting the first joint surface and a material constituting the second joint surface is an elastic material having a self-sealing feature.

(Emphasis added)

Thus, the invention of claim 1 includes a pump unit having several parts and a channel unit. The pump unit is specifically configured to address some of the matters described above. Specifically, as set forth in the claim, the pump unit includes a first joint surface and a channel through which the fluid is moved by the pumping mechanism. Importantly, the pump is configured with a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber.

The pump is configured so that the pressure dependence of the first throttle is larger than pressure dependence of the second throttle so that the pump can move the fluid in each direction depending on the driving wave form of the piezoelectric element. A preferred embodiment of the pump unit is disclosed in at least paragraphs [0032] - [0043] of the present specification.

In this configuration, fluid may be drawn from a reservoir which may be located on the side of the channel unit, received at the pump unit at the first joint surface, moved through the channel of pump unit by virtue of the pumping mechanism and returned to the channel unit, again at the first joint surface. This configuration allows a clean separation along the first joint surface between the pump unit and both the source of the fluids and the channels into which the fluids are delivered by the pump unit.

In order to render obvious claim 1, the cited reference must disclose or suggest every limitation of the claim. As explained more fully below, Ouellet et al, Zanzucchi and Dubrow do not disclose or suggest every limitation of claim 1 and thus cannot render this claim obvious.

As noted above, claim 1 -- as now presented -- requires a certain configuration for the pumping mechanism. Specifically, claim 1 requires that the pumping mechanism include:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

None of Ouellet, Zanzucchi or Dunbrow disclose or suggest a pump of this configuration, much less a pump of this configuration configured in combination with the other elements of the microfluidic device of claim 1.

Ouellet discloses a method for fabricating a microstructure for microfluidics applications. Specifically, Ouellet discloses a method using semiconductor type micro fabrication techniques that can form a buried channel. That is, Ouellet discloses that an etchable material can be covered with a support layer, a narrow opening can be cut in the support layer, an isotropic etch can be introduced via the narrow opening so as to etch away the underlying etchable material and thus undercut the overlying support layer to form a channel under the overlying support layer. After the undercut is achieved, the narrow opening is closed by depositing an additional layer. Ouellet also discloses that electronic elements can be made at the same time using semiconductor manufacturing techniques. Thus, the teaching of Ouellet is a fabrication technique that allows "the micro-channels [to be] closed without the use of a second substrate and without the use of thermal bonding." (col. 5, lines 22-23).

While Ouellet makes an off hand comment that the disclosed structure can be used with a micropump, Ouellet fails to disclose or illustrate any type or configuration of micropump whatsoever. Ouellet also fails to disclose how or where a micropump would be used with the etched structure. While Ouellet lists various items of prior art, Ouellet does not explain the teachings of this art or suggest how any pump (if any) that might be shown in the art would be configured, used or integrated into the structure shown in Ouellet.

Thus, specifically referring to claim 1, Ouellet does not disclose a microfluidics system of the type having a pump unit having any particular configuration, much less one which has the specific configuration set forth in the claim.

Because Ouellet does not disclose these limitations of claim 1, Ouellet, by itself, cannot render obvious claim 1.

Zanzucchi discloses a liquid distribution system for selectively distributing liquid from liquid sources to a plurality of cells. The system of Zanzucchi is configured so that fluid from the sources can be selectively moved to the cells. The system relies on micropumps for pumping the liquid to move it to the cells. Zanzucchi suggests that various

types of pumps can be used, but says that electrode-based pumps that rely on electrohydrodynamic pumping and/or electroosmosis are preferred.

Although Zanzucchi discloses a system that preferably uses electrode-based pumps and which says that other types of pumps can be used, Zanzucchi does not disclose a pumping mechanism that includes:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

Because Zanzucchi does not disclose these limitations of claim 1, Zanzucchi, by itself, cannot render obvious claim 1.

Dubrow discloses various configurations of microfluidic devices. The structure of all of the systems disclosed comprise a substrate 302, which has various channels fabricated into the surface thereof and a second planar layer which overlays the substrate. The second planar layer has holes disposed through it to form the various reservoirs. (See Fig. 3 and col. 16).

As a primary form of moving the fluid, Dubrow discloses the technique of applying a voltage between the reservoir and the channel to cause fluid flow by electrophoretic transport. Such an electrophoretic transport system is unable to read on the specific structural limitations of claim 1 which requires, among other things, a pumping unit having a channel with a defined configuration, and a specific configuration of pumping mechanism, etc.

Dubrow also states that fluid may be transported in this structure by pressure or pneumatically driven systems, including micropumps. However, Dubrow does not disclose or describe any particular structure for employing pressure or pneumatically driven systems,

or micropumps. Instead, at best, Dubrow implies that the fluid in the reservoirs can be forced by pressure or a pump into the underlying channels in the substrate.

This disclosure by Dubrow does not show the specific aspects of the microfluidic device and pump unit recited by claim 1. Specifically, among other things, Dubrow does not disclose a pumping mechanism that includes:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

Because Dubrow does not disclose these limitations of claim 1, Dubrow, by itself, cannot render obvious claim 1.

With respect to the combination of Ouellet, Zanzucchi or Dunbrow, as described above, none of Ouellet, Zanzucchi or Dunbrow disclose or suggest the specific aspects of the microfluidic device or the specific configuration of the pumping mechanism recited by claim 1. Because none of these references individually discloses or suggest the specific configuration of the pump as claimed, the combination of these references also fails to disclose or suggest the specific configuration of the pump as claimed. Accordingly, because the combination of these references do not disclose or suggest all of the limitations of the claim, the combination of these references is unable to render obvious the invention of claim 1.

Claims 2, 5 and 19 depend from claim 1 and are thus not obvious for at least the same reasons as claim 1.

The discussion will now turn to claim 6 and to claim 7 which depends from claim 6. Claim 6 is directed to a microfluidic device including a pumping mechanism having a particular configuration. Specifically, claim 6 requires a pumping mechanism that includes:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

As described above with respect to the rejection of claim 1, none of Ouellet, Zanzucchi or Dunbrow, singly or in combination, disclose or suggest a microfluidic device having a pumping mechanism as quoted above. In order to render the present claim obvious, the references, individually or together must disclose or suggest every limitation of the claim. Because these references do not disclose or suggest the specific configuration of the pump as claimed, the combination of these references fails to render obvious the invention of claim 6.

Claim 7 depends from claim 6 and is thus not obvious for at least the same reasons as claim 6.

The discussion will now turn to claim 10 and to claims 11 and 14 which depend from claim 10. Claim 10 is directed to a microfluidic device including a pumping mechanism having a particular configuration. Specifically, claim 10 requires a pumping mechanism that includes:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

As described above with respect to the rejection of claims 1 and 6, none of Ouellet, Zanzucchi or Dunbrow, singly or in combination, disclose or suggest a microfluidic device having a pumping mechanism as quoted above. In order to render the present claim obvious, the references, individually or together must disclose or suggest every limitation of the claim. Because these references do not disclose or suggest the specific configuration of the pump as claimed, the combination of these references fails to render obvious the invention of claim 10.

Claims 11 and 14 depend from claim 10 and are thus not obvious for at least the same reasons as claim 10.

The discussion will now turn to claim 15 and to claim 16 which depends from claim 15. Claim 15 is directed to a microfluidic device including a pumping mechanism having a particular configuration. Specifically, claim 15 requires a channel used for a microfluidic device that includes a channel unit and a pump unit, where the pump is a type having a specific configuration. Specifically, the pump unit is the type that has a first joint surface, a pumping mechanism, and a channel that forms a flow path through which a fluid flows, opposing ends of said channel each opening to the first joint surface, and where the pumping mechanism includes:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

As described above with respect to the rejection of claim 1, none of Ouellet, Zanzucchi or Dunbrow, singly or in combination, disclose or suggest a microfluidic device having a pumping mechanism as quoted above. In order to render the present claim obvious, the references, individually or together must disclose or suggest every limitation of the claim. Because these references do not disclose or suggest the specific configuration of the pump as

required, the combination of these references fails to render obvious the invention of claim 15.

Claim 16 depends from claim 15 and is thus not obvious for at least the same reasons as claim 15.

Accordingly, in view of the foregoing, it is respectfully requested that the rejection of claims 1, 2, 5-7, 10, 11, 14-16, and 19 under 35 U.S.C. § 103(a) as being unpatentable over Ouellet in view of Zanzucchi and Dubrow, be reconsidered and withdrawn.

The rejection of claims 3, 8, 12, and 17 under 35 U.S.C. § 103(a), as being unpatentable over Ouellet in view of Zanzucchi and Dubrow as applied to claims 1, 2, 5-7, 10, 11, 14-16, and 19 and further evidenced by Wikipedia, is respectfully traversed based on the following.

Claims 3, 8, 12, and 17 depend, respectively, from claims 1, 6, 10 and 15, each of which are discussed above. The rejection of these claims, in addition to applying Ouellet, Zanzucchi and Dunbrow, adds Wikipedia for the proposition that PDMS is optically clear.

Regardless of what Wikipedia discloses with respect to PDMS, the Wikipedia disclosure of PDMS (http://en.wikipedia.org/wiki/Polydimethylsiloxane (last visited May 20, 2009)) does not disclose any type of pump mechanism, much less a pumping mechanism that includes the following limitations of each of claims 1, 6, 10 and 15:

> a pumping chamber having a diaphragm to which a piezoelectric element is attached, a first throttle channel connected to one side of the pumping chamber, and a second throttle channel connected to the other side of the pumping chamber, wherein pressure dependence of the first throttle is larger than pressure dependence of the second throttle so as to be capable of transporting fluid each direction depending on a nonsymmetrically-shaped driving wave form of the piezoelectric element.

Because the Wikipedia disclosure of PDMS does not disclose the specific pumping mechanism required of the claims, the Wikipedia disclosure of PDMS cannot cure the deficiency of Ouellet, Zanzucchi and Dunbrow to render obvious claims 1, 6, 10 or 15. That is, none of Ouellet, Zanzucchi, Dunbrow or the Wikipedia disclosure of PDMS, singly or in combination, disclose or suggest a microfluidic device having a pumping mechanism as quoted above. Because these references do not disclose or suggest the specific configuration of the pump as claimed, the combination of these references fails to render obvious the invention of claims 1, 6, 10 and 15.

Claims 3, 8, 12, and 17 depend, respectively, from claims 1, 6, 10 and 15 and are thus not obvious for at least the same reasons as claims 1, 6, 10 and 15.

Accordingly, in view of the foregoing, it is respectfully requested that the rejection of claims 3, 8, 12, and 17 under 35 U.S.C. § 103(a) as being unpatentable over Ouellet in view of Zanzucchi and Dubrow as applied to claims 1, 2, 5-7, 10, 11, 14-16, and 19 and further evidenced by Wikipedia, be reconsidered and withdrawn.

CONCLUSION

In view of the foregoing amendments and remarks, this application is considered to be in condition for allowance, and an early reconsideration and a Notice of Allowance are respectfully requested.

This Amendment does not increase the number of independent claims, does not increase the total number of claims, and does not present any multiple dependency claims. Accordingly, no fee based on the number or type of claims is currently due. However, if a fee, other than the issue fee, is due, please charge this fee to Sidley Austin LLP Deposit Account No. 18-1260.

If an extension of time is required to enable this document to be timely filed and there is no separate Petition for Extension of Time filed herewith, this document is to be construed

as also constituting a Petition for Extension of Time Under 37 C.F.R. § 1.136(a) for a period of time sufficient to enable this document to be timely filed.

Any other fee required for such Petition for Extension of Time and any other fee required by this document pursuant to 37 C.F.R. §§ 1.16 and 1.17, other than the issue fee, and not submitted herewith should be charged to Sidley Austin LLP Deposit Account No. 18-1260. Any refund should be credited to the same account.

Respectfully submitted,

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